Regional/Seasonal Biases in Aquarius/SMAP SSS

Oleg Melnichenko & Peter Hacker
International Pacific Research Center, SOEST, University of Hawaii

Aquarius Cal/Val Meeting, 10-12 January 2017, Santa Rosa, CA
**Box analysis:** \[ S(t) = A_{12} \cos(\omega_{12} t + \varphi_{12}) + A_6 \cos(\omega_6 t + \varphi_6) \]

Long-term trends seem to be real; seasonal variability is contaminated by seasonal/regional biases (significant in some places)
Static bias (3-year mean) with respect to Argo (APDRC)

Considerable improvements from 4.0 (4.2.1) to 4.5.0 at high latitudes

Bias maps are computed from monthly fields using 6 x 6 degree boxes on a 3-degree grid. To suppress unwanted small scale signals, the bias maps are smoothed with a 2D filter of ~800 km cut-off wavelength.
Static bias (3-year mean) with respect to Argo (APDRC)

Ascending  Descending  Difference (A–D)

Differences between data versions (from previous slide)

V4.5.0-V4.0  V4.5.0-V4.0  V4.5.0-V4.0

V4.5.1-V4.5.0  V4.5.1-V4.5.0  V4.5.1-V4.5.0

Considerable improvements from 4.0 (4.2.1) to 4.5.0 at high latitudes

Bias maps are computed from monthly fields using 6 x 6 degree boxes on a 3-degree grid. To suppress unwanted small scale signals, the bias maps are smoothed with a 2D filter of ~800 km cut-off wavelength.
The error statistics are calculated by comparing Argo buoy measurements (z<6m) for a given week with SSS values at the same locations obtained by interpolating the corresponding Aquarius L3 SSS maps.
Latitude-time distribution of the zonally averaged differences between weekly SSS maps and the corresponding Argo buoy data

Differences between data versions (from previous slide)

The error statistics are calculated by comparing Argo buoy measurements (z<6m) for a given week with SSS values at the same locations obtained by interpolating the corresponding Aquarius L3 SSS maps.
The error statistics are calculated by comparing Argo buoy measurements (z<6m) for a given week with SSS values at the same locations obtained by interpolating the corresponding Aquarius L3 SSS maps. The static (3-yr mean (September 2011-August 2014)) biases are subtracted.
Latitude-time distribution of the time-varying part of the differences between weekly L3 SSS maps and the corresponding Argo buoy data.

The error statistics are calculated by comparing Argo buoy measurements (z<6m) for a given week with SSS values at the same locations obtained by interpolating the corresponding Aquarius L3 SSS maps. The static (3-yr mean (September 2011-August 2014)) biases are subtracted.
Latitude-time distribution of the time-varying part of the differences between weekly L3 SSS maps and the corresponding Argo buoy data.

The error statistics are calculated by comparing Argo buoy measurements (z<6m) for a given week with SSS values at the same locations obtained by interpolating the corresponding Aquarius L3 SSS maps. The static (3-yr mean (September 2011-August 2014)) biases are subtracted.
Amplitude of the annual cycle in the bias field

Amplitudes of the annual and semiannual cycles in the bias are determined by harmonic analysis of the bias fields

$$\text{Bias}(x, y, t) = A_{12}(x, y) \cos(\omega_{12} t + \phi_{12}(x, y)) + A_6(x, y) \cos(\omega_6 t + \phi_6(x, y))$$
Amplitudes of the annual and semiannual cycles in the bias are determined by harmonic analysis of the bias fields

\[\text{Bias}(x, y, t) = A_{12}(x, y)\cos(\omega_{12}t + \phi_{12}(x, y)) + A_6(x, y)\cos(\omega_6 t + \phi_6(x, y))\]
**Static biases**: significant reduction in V4.5.0, particularly at high latitudes

**Time-varying biases**: persist; no apparent reduction in V4+. The time varying biases consist of primarily annual and semi-annual signals. The amplitude of the spurious annual (semi-annual) signal can be a significant error compared to the Argo-derived annual (semi-annual) cycle regionally; thus, the biases need to be characterized and quantified (e.g., spatial distributions of amplitude and phase) for science and applications users.

**Aquarius vs SMAP**
Aquarius vs SMAP
Static (time-mean) bias with respect to Argo (APDRC)

- Aquarius V4.5.0 (A+D)
- SMAP V2.0

Zonal average

<table>
<thead>
<tr>
<th></th>
<th>V4.0</th>
<th>V4.5.0</th>
<th>V4.5.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bias</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Zonal average

<table>
<thead>
<tr>
<th></th>
<th>V4.0</th>
<th>V4.5.0</th>
<th>V4.5.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bias</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The error statistics are calculated by comparing Argo buoy measurements (z<6m) for a given week with SSS values at the same locations obtained by interpolating the corresponding L3 SSS maps.
EOF decomposition of time-varying bias

Aquarius V4.0 (ascending)

EOF 1 (25% VAR)
EOF 2 (18% VAR)

Dashed – original time series; solid – fitted annual cycle

SMAP V2.0

EOF 1 (20% VAR)
EOF 2 (14% VAR)